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THE QUESTION OF ETHER DRIFT

By Dr. Edwin E. Slosson

A dramatic culmination of a controversy that has divided the scientific world for more than forty years was the appearance upon the same program of the National Academy of Sciences meeting here last week of two papers which present new evidence on the question of Einstein's theory of relativity. The first paper was by the President of the Academy, Prof. A. A. Michelson of the University of Chicago, whose historic experiments in 1881 first showed that there was something wrong about our traditional ideas of space and time, and so led to the Einstein theory. The second was by Prof. Dayton C. Miller of the Case School of Applied Science, Cleveland, who has recently repeated the original Michelson experiments on the top of Mount Wilson, California, and got different results whichconflict with the Einstein theory.

The question at issue is whether there is an ether pervading all space and if so whether it is stationary or carried along by moving matter.

All attempts to prove the existence of the ether or to measure "ether drift" through moving bodies have so far failed. The crucial experiment was that tried by Michelson in cooperation with Morley in 1881. He set up in the basement of the Case School a marvelously accurate instrument named the "interferometer", because it measures the interference of fringes, or black and white bands, produced when two beams of light come together in such a way that their crests and troughs conflict.

Besides rotating on its axis from west to east at the rate of a third of a mile a second, the earth revolves around the sun once a year, at a rate of 18 miles a second, and the sun with the earth and the rest of the planets is moving through space at the rate of about 10 miles a second. But whichever way Michelson turned the arms of his interferometer, he found no difference in direction and got no evidence of ether drift. He repeated the experiment in 1887 with more accurate apparatus and in the same place but still got negative results.

This seemed to prove that the earth did not move through a fixed ether. But to assume the contrary, that the earth did not move but was permanently at rest in a fixed ether, was inadmissible because that would upset Copernicus and all the astronomers since.

No adequate explanation of these two conflicting experiments was produced till 1905, when Einstein put forward his special theory of relativity which disregards the ether altogether. This theory carried with it such revolutionary consequences as to the nature of space and time that men began to question whether there might not be some flaw in the Michelson-Morley experiment, on which such a vast edifice of speculation had been built by Einstein and his disciples. So Professor Miller constructed a more elaborate interferometer apparatus with all possible precautions and refinements. When he tried it out inthe place of the previous experiments, the basement of the building, he got the same result, that is, no adequate evidence of ether drift.

But a few months ago he set up the apparatus on the summit of Mount Wilson, 5000 feet above the sea, and this time got a positive displacement of the fringes . If Miller's experiment is confirmed it would indicate that the ether is somehow tangled up and carried with the earth at points beneath the surface, like the basement laboratory, but that out on a mountain top, somewhat away from the main mass of the earth, the ether does drift by, or through, matter to some extent. This means that we have in the ether a sort of fixed framework and can, in spite of Einstein, get evidence of real motion and not merely relative motion of the stars and the earth. There is then a definite clash between the results so far obtained by Miller and Einstein' s special relativity theory.

But the paper read before the Academy by Dr. A. H. Compton of the University of Chicago giving the result of the new experiments by Professor Michelson and himself on ether drift accords with Einstein's theory instead of contradicting it. In this apparatus a divided ray of light was sent in opposite directions through a rectangle of water-pipe over a mile long in order to see if the rotation of the earth made any difference on the speed of light in different directions. The measurements with the interferometer were almost exactly the figure required by the theory of relativity, and Professor Michelson in a preliminary announcement of the result in a recent public lecture in Chicago said: "Provisionally there is no question that the Einstein theory is correct and this experiment is one more striking confirmation of his brilliant work". But this result is also in accordance with the old ether theory so it does not definitely decide between them. Besides, this experiment was performed underground like those in the basement of the Case School and, if Professor Miller's experiments are right, different results may be expected on the mountain tops.

With the possible exception of Miller's recent results on Mount Wilson the Einstein theory has been substantiated on all points open to experimental evidence. His prediction of a displacement in the position of stars close to the sun was verified by eclipse observations of Eddington of England and Campbell of California. His prediction of a shift in the spectral lines from the sun was verified by St. John at Mount Wilson. The theory of relativity also affords an explanation of the irregularities in the orbit of Mercury, the distribution of the fine lines of the spectrum of light as calculated by Sommerfeld, of the results of the Michelson-Morley experiment and of the continued production of heat from the sun and stars by the conversion of their substance into radiant energy.

ETHER DRIFT EXPERIMENTS CONFIRM EINSTEIN THEORY

New light on the old questionof the relation of matter to the ether of space comes from the experiments by Profs. A. A. Michelson and H. G. Gale of the University of Chicago reported to the National Academy of Sciences at its

annual meeting held recently in Washington.

The plan of it was based upon an ingenious idea suggested by Michelson in 1904 and recently urged by Dr. Ludwik Silberstein of Rochester, as a test of the relativity theory. Suppose we had a big steel pipe running around the world on an east and west line and mirrors so arranged in it that they would reflect a ray of light all the way around. Let us then send one ray east and the other west and match them up when they come back from their circuit of the earth to see if one took longer than the other. Now if the earth does not revolve of course the ray going east will get back in just the same time as the ray going west. But if the earth is moving from west to east the ray running east will take longer to return to the starting point than the ray running west because that point has moved eastward in the meantime.

They enclosed a certain area of the earth's surface at Clearing, Ill., near Chicago, by a rectangle of air-tight water-pipe a foot in diameter. The pipes were laid level underground and the air was exhausted by means of a pump to about a fiftieth of an atmosphere so as to avoid interference with vision due to air currents. The light from a slit in front of an arc lamp at one corner was directed against a glass plate coated with a thin film of gold and set at an argle so that half the ray of light passed through it and so straight ahead along the pipe, while the other half was reflected at right angles, and so sent around the rectangle in the opposite direction. At each of the other three corners a mirror was placed in the pipes so as to reflect the rays along the next side of the rectangle.

The two rays having travelled more than a mile by opposite routes were matched to see whether their waves coincided or whether one had fallen behind the other owing to the earth's rotation. A shorter circuit was used to establish the zero point. The fringes, or alternate dark and bright lines, due to interference of waves were viewed through a seven-foot telescope and measured with a micrometer.

Two hundred determinations were made on various days and by different observers, and the average gives a displacement of the interferometer fringes, due to the earth's rotation, of about one quarter of a fringe. The exact figure found in the experiments is 0.23, while the figure calculated in accordance with Einstein's theory is 0.24. This is a remarkably close agreement, considering the difficulty of such an experiment, and proves that the ether is not appreciably dragged along with the earth in its rotation. If the observations had shown no displacement of the fringes the experiment would have been contrary to the special relativity theory of Einstein, but the results obtained may also be interpreted in harmony with the older theory of a stagnant ether so are not decisive between them.

Michelson's new experiments are incompatible with his experiments of 1881-7 from the standpoint of the old ether theory, but they may be reconciled by adopting the Einstein point of view.

As a result of a warm ocean current, the city of Sitka, Alaska, has the same average temperature as Washington, D.C., although it is nearly 1200 miles farther north.

Young men who collect the most human heads make the biggest hit with the girls in the head-hunting islands of the East Indies.

MT. WILSON TELESCOPE REVEALS STARS IN NEBULAE

Many of the spiral nebulae and the irregular nebulae in parts of the sky outside the milky way, which have long defied the efforts of astronomers to see them as other than continuous areas of light, have surrendered to the largest telescope in the world, the great 100-inch reflector at the Mt. Wilson Observatory in California, Dr. Edwin Hubble told members of the American Philosophical Society at its recent meeting in Philadelphia. Photographs made of these objects by Dr. Hubble have revealed the stars of which they consist and demonstrate that the reason these stars have not been seen before has been because of lack of sufficiently powerful instruments, just as the Milky Way itself, consisting of millions of stars, appears continuous to the unaided eye.

The irregular nebulae are now shown to be objects like the Magellanic Clouds, seen in the southern hemisphere and resembling the Milky Way, but so distant that the largest instruments hitherto in use have not been able to resolve them.

PURE SILVERY ALUMINUM ACHIEVED BY NEW PROCESS

Pure aluminum, the goal of many years of research, will now be available in commercial quantities through the development of a new refining process described by Dr. Francis C. Frary, speaking before the American Electro-Chemical Society at Niagara Falls. The term "pure aluminum" is, of course, still a relative one, but its use is certainly now justified because the new "Hoopes" refining process makes this metal with less than two one-hundredths of one per cent. of impurity, even on a full commercial scale.

Previously the highest purity aluminum ordinarily available contained 99.7 per cent. of this metal. Some of the new product is as pure as 99.983. The principal impurity is copper, but traces of iron and silicon are also present. To make this exceedingly pure metal a special refining process using melted salts of sodium, aluminum, and barium fluoride, is used. The impure molten aluminum is carried by the electric current upward through the molten layer of these salts and is separated on top in a molten form from which point it can be poured or ladled off into molds.

This pure aluminum has a beautiful silver color and luster which it retains very well. The bluish tinge characteristic of commercial aluminum as found in the ordinary kitchen is eliminated because of the low content of iron and silicon. The first of these impurities causes a grayish color, and the second a purplish color; and either causes the metal to become dull and lusterless on comparatively short exposure.

HEART-BEAT CONTROLS NEW X-RAY MACHINE

Better X-ray pictures of conditions in the lungs, due to elimination of blurring motions, are promised as the result of an invention described recently before the annual meeting of the American Philosophical Society, at Philadelphia, by Dr. F. Maurice McPhedran and Charles N. Weyl, both of the University of Pennsylvania.

The difficulty with many X-ray pictures taken by methods now in use, Dr.

McPhedran explained, is that the beat of the heart causes a certain amount of motion, and only pictures taken during the brief pause between beats are of real value in diagnosing disease and in tracing the course of its cure. The new machine operates in such a way that the photographic plate is exposed only when the heart is quiet; so that all pictures are taken under uniform conditions, and at the most favorable instant for getting the best photographs.

NEW TESTS PROPOSED FOR COLLEGE FRESHMEN

Systematic search among high school students for those really fitted to go to college, and the examining of such prospective freshmen for the subjects they can best master, were set forth as new aims in psychological testing by Prof. Carl E. Seashore of the University of Iowa, speaking before the National Academy of Sciences at its annual meeting held recently in Washington. Prof. Seashore also advocated the building of scientific tests for achievement, as corollaries of the intelligence or capacity tests now in use.

HELIUM FORMED BY EARTH RADIOACTIVITY

How helium, the valuable gas used to fill modern dirigibles, is being slowly but steadily formed by radioactive processes in the earth's crust and thence liberated into gas pools or into the air was explained before the National Academy of Sciences, at its recent meeting in Washington, by Dr. S.C. Lind, associate director of the Fixed Nitrogen Research Laboratory, Washington.

Increasingly larger quantities of helium are found stored in natural gas pools, said Dr. Lind, but this supply is no greater than the helium which could have accumulated from radioactive processes in the earth's crust during known geological time.

It is evident that a large proportion of the helium must be released from the radioactive minerals, because less than one-third of the amount that would be produced by atomic disintegration is found in the minerals themselves.

He suggested that the escape of the helium into gas craters or into the air may be due to the formation of other gases such as nitrogen and carbon dioxide under the action of radium. These gases, when liberated, sweep the helium with them.

WHEAT GERM RICH IN FERTILITY VITAMIN

The action of vitamin "E", the recently discovered fertility vitamin, whose presence in the diet is necessary for the production of offspring, was described before the annual meeting of the National Academy of Sciences, at Washington, by Drs. Herbert M. Evans and George O. Burr, of the University of California.

Certain facts about the new vitamin, not hitherto made public, were brought out in the discussion. The type of sterility caused by the lack of the vitamin differs in male and female animals. In the male a true sterility occurs,

with death of the sex cells and even the disappearance of the tissues that normally give rise to them. In the female, however, the first steps in the production of young can take place, but the partly developed embryos die and are resorbed. Yet so powerful is the newly discovered dietary factor that after such a failure has taken place, the feeding of a single natural food containing it will cause the production of healthy young at the next mating.

Various natural foods were shown to contain the necessary vitamin in widely differing concentration. It is present, though not in great amount, in various kinds of animal tissue, especially muscle, fat, and certain of the vital organs, though it is low in the heart, spleen, brain, kidney, and strangely enough, in the male reproductive glands themselves. There is little of vitamin "E" in milk fat and in whole milk powder, and there is more of it in the milk of cows that have had access to fresh alfalfa pasturage than in that of other cattle. Cod liver oil, though high in vitamins "A" and "D", is notably lacking in "E".

"We have found it in oats, corn, and especially wheat, where it is low in the endosperm, but concentrated in the embryo," said Dr. Evans. "The richness of wheat germ in 'E' is extraordinary."

By a complicated chemical process, involving not less than eleven steps of extraction, distillation, precipitation, etc., a highly purified extract of wheat germ was obtained, which apparently contained as much vitamin "E" in a drop as existed in several ounces of ordinary foods. Fat soluble vitamin E was formerly known as factor X, but has now been promoted to a regular place in the alphabetical sequence.

BOLL WEEVIL HAS SUPERSENSITIVE NOSE

The important secret of the cotton plant's irresistible attractiveness for the cotton boll weevil has been investigated - not by psychoanalysis, but by chemical analysis of the plant's character. How they analyzed several tons of cotton and isolated several odorous substances was told by Dr. Frederick B. Power, and V.K. Chesnut, of the U.S. Bureau of Chemistry, at the meeting of the National Academy of Sciences, at its annual meeting held in Washington recently.

A ten-acre field of choice, healthy upland cotton at the government laboratory at Tallulah, Alabama, was given over to the chemists. The plants were cut and within two hours almost three tons of leaves, flowers, squares, and a few small bolls were being distilled.

The 1,400 gallons of material thus obtained were then distilled again so that the odorous constituents might be concentrated in a smaller volume. Seventy-eight gallons of chemical "cotton" were left, and the chemists returned with this to the Bureau of Chemistry.

Twelve individual substances were identified in analyses of the distilled material by Dr. Power and Mr. Chesnut. Ammonia and trimethylamine were the outstanding odorous substances, and while ammonia predominated, the trimethylamine is regarded as the perfume which is so alluring to the weevil.

"It has been recorded that so small an amount of trimethylamine as five ten-millionths of a gram can be distinctly detected by its odor," the chemists

told the meeting.

Entomologists testing the power of this substance to attract the boll weevil have found that the sensitive insect detects an extract so faint that it seems entirely odorless to a human being. One part of trimethylamine in 1,000 parts of water makes a perfume that is almost too strong for the weevil's discriminating taste.

GOLD KILLS GERMS BY STEALING SULFUR

Compounds of the so-called "heavy metals", like gold, silver, mercury, copper and lead, are effective disinfectants because they break down the delicate chemical balance in living matter by robbing it of its sulfur. Results of researches embodying this theory were presented at the annual meeting of the National Academy of Sciences, held recently in Washington, by Drs. Carl Voegtlin and J.M. Johnson and Miss Helen A.Dyer, of the Hygienic Laboratory at Washington.

The investigation was undertaken to find out the fundamental chemical cause for the poisonousness of such common disinfectants as bichloride of mercury and copper sulfate. The poisonous properties of the heavy metals have been known for a long time, but the chemical mechanism of their action had never been discovered. Dr. Voegtlin and his associates learned that the greed of these metals for sulfur lay at the bottom of the violence of their attack on living matter. In the cell, an important part of life activity depends on a combination of atoms of hydrogen and sulfur, which act as go-betweens in the chemical processes of respiration. The atoms of the heavy metals, crashing into this delicate traffic situation and grabbing the sulfur, upset the balance and cause the death of the cell. Dr. Voegtlin discovered further that he could neutralize the poisonous effects of compounds of the heavy metals by adding to them compounds containing the sulfur-hydrogen group.

Dr. Voegtlin said that though this discovery goes to the bottom of the chemical action of this class of disinfectants, the work is not yet at a point where immediate applied results can be expected. He is working with organic gold compounds as possible remedies for syphilis, but states that, though effective, thus far they have not proved to be as good as the arsenical compounds now in use.

WHITE MAN MAY COMMUTE IN TROPICS

Seasonal, or even daily, changes of residence were suggested as a means of lessening the insidious influence of tropical climate on the white man, by Dr. Bowman C. Crowell, professor of pathology at Jefferson Medical College, at the recent meeting of the American Philosophical Society in Philadelphia.

Climate and disease, the two factors that have prevented the white race from establishing itself in the tropics, can be successfully combated, he declared; and the productiveness of the warm countries is so great that it might be economically feasible to provide for the cooling of houses, and in other ways to make it possible for the white man to be comfortable and healthy in the tropical environment.

"There is difference of opinion as to the effect of tropical climate," said Dr. Crowell, "Science has not been able to measure the unquestionably harmful influence on the nervous system of a constant temperature, bright sunshine, brilliant colors and the absence of seasonal variations. The equilibrium of the white man's nervous system and his energy and initiative are further disturbed by contact with impassive and at times stupid colored natives, by their untrustworthiness, and by the tendency to abuse of stimulants and general lowering of the moral tone.

"Scientific investigation has not shown, however, that climate is any insuperable barrier to the white man's successful continued life in the tropics, and further serious investigation of the subject is imperative."

The method of control and prevention of most of the important transmissible diseases, such as cholera, plague, malaria, typhus, yellow fever, and African sleeping sickness, are partially or fully known, he pointed out, and practical application of this knowledge is now largely a question of sufficient incentive.

STUDY OF SUN'S HEAT BRINGS LONG RANGE WEATHER FORECAST

Discovery of intimate relations between the heat of the sun and the weather that promise to be useful in weather prediction were announced tothe National Academy of Sciences by H. H. Clayton, of Canton, Mass., and Dr. C. G. Abbot of the Smithsonian Institution, Washington. The new predicting methods are the result of researches on the variations in solar radiation, carried on by Dr. Abbot for many years in two desert stations, one in Arizona and the other in northern Chile. Mr. Clayton, who was formerly in charge of the forecasting department of the Argentine Weather Service, has tried out his method in the southern republic, and claims encouraging progressin his longe range weather predictions.

Following utilization of solar radiation values in forecasting in Argentine, Mr. Clayton with the assistance of Dr. Abbot, continued his researches and tested the possibility of the application of the results to forecasting weather at places in the United States.

"A preliminary investigation showed that, with increased solar radiation for a day or two, areas of increased pressure formed in central North America, or in the Rocky Mountain region, and progressed eastward and southward to the eastern part of the United States and that there was a typical sequence of events on which weatherforecasts might be based," Mr. Clayton said. "New York being an important industrial center was selected as a point for testing the forecasts of daily maximum temperature for the interval three to five days in advance, and they were begun in the autumn of 1923. These forecasts were verified by Dr. Abbot for the year December 1, 1923 to December 1, 1924, by a rigid scientific method which does not permit of personal bias. It was found that when high temperatures were predicted the temperature on each of the three days averaged above normal, and when low temperature was predicted it averaged below normal. The mean of the 3- to 5-day interval was 1.0 degrees Fahrenheit above normal when high temperature was predicted, within 0.3 degrees Fahrenheit of normal when normal temperature was predicted, and 2.1 degrees Fahrenheit below normal when low temperature was predicted."

"It was found that with every class of variation of solar radiation, whether of a few days', a few months', or many years' duration, as in the sunspot period

the normal areas of high and low pressure in the earth's atmosphere swing north and south in unison with the changes insolar radiation and thus determine excesses or defects of temperature and rainfall which swing north and south with th pressure, the effects increasing in intensity with increasing latitude," Dr. Clayton said. "In the northern United States and Canada these changes may amount to as much as 40 degrees Fahrenheit attending a departure of only one per cent. of solar radiation on either side of the normal.

"It was already known from Dr. Abbot's work that the amountof heat radiation from the sun varies with the number of sunspots in the eleven-year sunspot period being greatest at maximum sunspots. Further research discloses that the day to day variations of solar radiation are closely related to the position of sunspots and faculae on the face of the sun as seen from the earth. When the spots and faculae are on the central meridian of the sun, there is a diminution of solar radiation, probably resulting from absorption , and an increase above normal when the spots and faculae are on the edges of the sun. The side of the sun on which the spot is located averages cooler than the opposite side, and there appear to be periodic oscillations of about 3½,7, and 14 days, which are in some way related to solar conditions.

"When the meteorological data in the United States are compared with the pressure and temperature in the UnitedStates, the same relations are found as would be expected from the correlated changes in solar radiation. The passage of spots across the central meridian of the sun is immediately followed by low pressure at central continental stations like Winnipeg, and higher pressure is found at the same stations on the average when the spots and faculae are on the eastern and western limbs of the sun.

"The relation to the temperature is opposite to that of the pressure."

SAYS EARTH CRUST SLIDES ON GREAT SEA OF GLASS

A theory of mountain chain formation based on the slow sliding of whole continental blocks over a substratum of volcanic glass was propsed before the recent meeting ofthe American Philosophical Society, at Philadelphia by Dr. Reginald A. Daly of Harvard University.

According to Dr. Daly's theory, great sections of the earth's crust, slowly heaved and tilted out of a stable position, gradually migrate in the direction of their slope. This slope may be very slight, and migration very slow, even a few inches a century, yet it goes on for such long periods that great changes, even the formation of huge mountain ranges, may take place.

Such a "downstream" migration of a continental block, Dr. Daly said, could not be imagined over a fixed and rigid base; but " for good reasons we may assume the earth's crust to be underlain by a universal substratum of basaltic glass at a temperature of 1200 to 1600 degrees Centigrade, or 2200 to 2900 Fahrenheit. The rigidity or stiffness of the substratum is great because of the hydrostatic pressure upon it; yet, as in the case of pitch, the resistance to flow breaks down with the passage of time, if a permanent, one-sided pressure or stress be applied to the substratum material."

Two things happen to a migrating continent, Dr. Daly continued. The edge of the "downstream" side, upon reaching the limit of its migration and encountering resistance, wrinkles and crumples into mountain folds, like the outer edge of flowing tar or molasses. On the "upstream" side the crust is stretched and finally cracked, allowing the interior magma to come to the surface as great non-volcanic lava flows.

FEWER DEATHS FROM DIPHTHERIA

Diphtheria, which takes its toll so largely among young children, is being held in check in most sections of the country, but this does not necessarily mean that all of the big battles with the disease have been fought. This is the situation presented in a new study of diphtheria mortality in cities of the United States, made by the American Medical Association.

The general outlook at the present time is encouraging, according to the report. Fourteen large cities succeeded in keeping their diphtheria death rate below five per 100,000 population, whereas none averaged so low in 1920-23.

In the last years of the nineteenth century an annual record of more than 100 deaths from diphtheria in 100,000 population was not unusual in a number of American cities. Such records are unknown now. Only five of the large cities had a diphtheria rate of more than 20 in 1924, and the highest of these was 23.

"The cities in the mountain and Pacific states, in contrast to those in almost all other sections of the country, are continuing to have an excessive diphtheria mortality", the report states. "Evidently the epidemic wave that has affected this region since 1920 has not yet spent its force.

"The undoubted epidemic prevalence of diphtheria on the Pacific coast in the last five years, as compared with the preceding decades, may well serve as a warning to other parts of the country that the relatively low diphtheria mortality now recorded in many American cities does not necessarily mean a permanent recession. It may be reasonably anticipated that new epidemic waves will arise and that official health agencies in many cities will be put to it to hold the ground already won."

ARTISTRY IN "ANNIE LAURIE" IS MEASURED BY SCIENCE

The elusive quality that makes a piece of music "art" when sung by one soloist, and "just a song" when ordinarily well sung by another can be made visible and can be measured, Dr. C.E. Seashore and Milton Metfessel, of the State University of Iowa, reported to the National Academy of Sciences at its annual session.

Phonograph records of "Annie Laurie" made by twelve singers of varying artistic abilities were brought to the laboratory of the two scientists, and records of the voices were produced on paper in the form of wavy marks by a photographic process. These wavy charts, some more irregular than others, were displayed before the academy meeting. The distinct personality of the sound waves of each voice could be seen in the record, and the amount of artistic emotion expressed by each singer could be measured.

The emotional quality in singing is not obtained by following the written score with strict precision, but by minute deviation from the notes, Dr. Seashore says. A mediocre singer may sing more accurately than a great opera star, but the famous star has mastered the expression of emotion by subtle variations in pitch, time, and intensity. And as everything that the singer conveys to the listener is conveyed by means of the sound waves, a study of the sound waves shows every detail of the singer's technic and artistry.

The photographic method of recording music is advocated for scientific purposes because it produces a permanent record with minute detail.